

# Advanced Unsteady Turbulent Combustion Simulation Capability for Space Propulsion Systems, Phase II

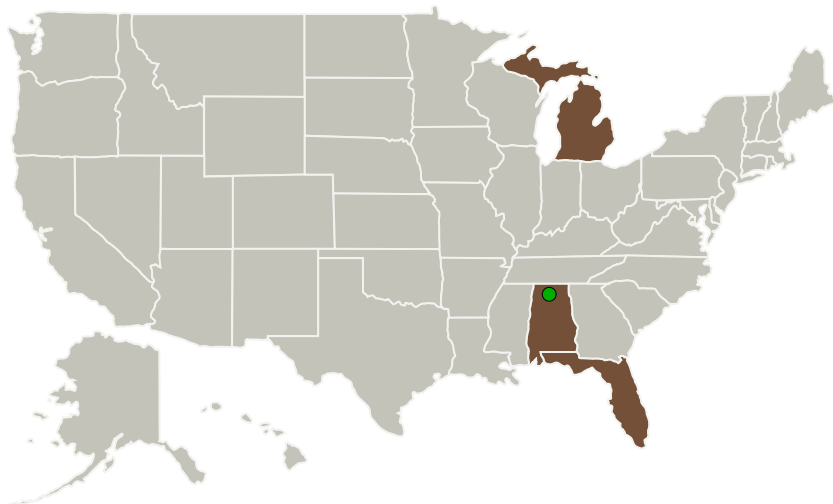
Completed Technology Project (2011 - 2013)



## Project Introduction

The innovation proposed here is a high performance, high fidelity simulation capability to enable accurate, fast and robust simulation of unsteady turbulent, reacting flows involving propellants of relevance to NASA (GOX/GH<sub>2</sub>, LOX/LH<sub>2</sub> and LOX/LCH<sub>4</sub>). The key features of this proposed capability are: (a) Hybrid RANS-LES (HRLES) methodology, and (b) flamelet modeling for turbulent combustion, incorporated in a proven existing solver called Loci-STREAM which has been developed by the proposing personnel under funding from NASA over the last several years. Basic flamelet methodology has been incorporated in Loci-STREAM during Phase 1 work and tested on gas-gas injectors of relevance to NASA. The enhancements in Loci-STREAM resulting from Phase 1 work have demonstrated an order of magnitude improvement in simulation turnaround times relative to existing capability for turbulent reacting flow applications at NASA. The work proposed during Phase 2 will extend the flamelet methodology to real-fluid flows, wall heat transfer and variable pressures. This will ultimately result in a state-of-the-art design and analysis tool to enable the accurate modeling of for multiphase combustion in solid and liquid rocket engines, combustion stability analysis, etc. which constitute critical components of versatile space propulsion engines part of NASA's deep space missions.

## Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
Streamline Numerics, Inc.	Lead Organization	Industry	Gainesville, Florida
● Marshall Space Flight Center (MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama
University of Michigan-Ann Arbor	Supporting Organization	Academia	Ann Arbor, Michigan

## Primary U.S. Work Locations

Alabama	Florida
Michigan	

## Project Transitions

▶ **July 2011:** Project Start

✓ **July 2013:** Closed out

## Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/138685>)

## Organizational Responsibility

## Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

## Lead Organization:

Streamline Numerics, Inc.

## Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

## Program Director:

Jason L Kessler

## Program Manager:

Carlos Torrez

## Principal Investigator:

Siddharth S Thakur

## Co-Investigator:

Siddharth Thakur

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## Technology Maturity (TRL)

Start: **4**  
Current: **5**  
Estimated End: **5**



## Technology Areas

### Primary:

- TX14 Thermal Management Systems
  - └ TX14.1 Cryogenic Systems
    - └ TX14.1.5 Cryogenic Analysis, Safety & Properties

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System